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Intraspecific Evolution in *Blasicrura interrupta* (Gray)

(Gastropoda : Cypraeidae)

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(3 Text figures; 1 Map)

The cowrie species *Blasicrura interrupta* (Gray, 1824) evidently originated in Indonesia where its ancestors, the Pliocene *B. insculpta* (Martin, 1899) and *B. nikinikiensis* (Schilder, 1928) have been found and its Recent ally *B. quadrimaculata* (Gray, 1824) has its center of distribution (see Schilder, 1941, p. 99). The Recent *B. interrupta* (in the broad sense) occupies the area between Sharks Bay, Ceylon, Okinawa, Palau Islands, Samoa, Tonga, and the southern Capricorn Islands; one beach shell is said to have been collected in the Lord Howe Islands in 1962 (ex coll. R. J. Griffiths sent by Ray Summers to the writer for examination; see below).

TAXONOMY

This area is rather large; therefore it seems to be less probable that the species has remained uniform in all areas from Ceylon to Tonga, than that it has differentiated into geographical or ecological intraspecific taxa with restricted habitat. In fact, nine taxa have been established; they are enumerated in the following list in chronological order; additional good figures have been cited in parentheses (); the type localities in brackets [] have been quoted from Schilder, 1966 b, p. 229.

Cypraea interrupta Gray, 1824, Zool. Journ. **1**: 376, (1870, Sowerby, Thes. Conch. Cypr. figs. 271 - 272; 1966, The Veliger **8**, plt. 44, fig. 64); [Ceylon]

Cypraeae quadrimaculatae varietas *pallidula* Gaskoin, 1849, Proc. Zool. Soc. London **1848**: 97 (1870, Sowerby, Thes. Conch. Cypr. fig. 275; 1966, The Veliger **8**, plt. 44, figs. 63, 65); [Philippines]

Cypraea rhinoceros Souverbie, 1865, Journ. de Conchyl. **13**: 156, plt. 5, fig. 1 (1870, Sowerby, Thes. Conch. Cypr. figs. 273, 274, 535; 1964, The Veliger **6**, plt. 25, fig. 33) [Art Island (New Caledonia)]

Cypraea prestoni Shaw, 1909, Proc. Malacol. Soc. London **8**: 299 (nom. nov. pro *C. interrupta* Gray) [Ceylon]

Blasicrura (Blasicrura) pallidula simulans Schilder & Schilder, 1940, Arch. Molluskenk. **72**: 43 (C. Cate, 1964, The Veliger **7**: 19, not figured) [Sharks Bay]

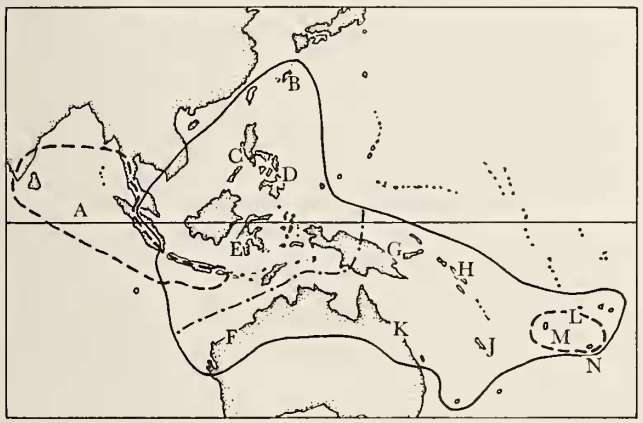
Blasicrura rhinoceros vivia Steadman & Cotton, 1943, Proc. South Austral. Mus. **7**: 323 (not figured) [Suva, Fiji]

Bistolida (Blasicrura) pallidula summersi Schilder, 1958, Arch. Molluskenk. **87**: 85, fig. 6 (1964, The Veliger **6**, plt. 25, fig. 34) [Nukualofa (Tongatabu)]

Cypraea (Blasicrura) pallidula luchuana Kuroda, 1960, Cat. Moll. Okinawa, p. 74, plt. 3, figs. 40 - 45 (1963, The Veliger **5**, plt. 15, fig. 2) [Okinawa]

Cypraea (Blasicrura) dayritiana CATE, 1963, The Veliger 5: 141, plt. 15, figs. 1, 3 (1966, The Veliger 8, plt. 44, fig. 62) [Marily Island, Coron Bay (Philippines)]

As the characters of these taxa pass each into the other, they should be regarded as parts of one species only; it must be called *interrupta* by law of priority, though the geographically central and phylogenetically primary taxon is *pallidula*. There are, however, three taxa which are rather distinct morphologically though overlapping geographically (see the Map) so that they should be classified



– – – – – borders of the prospecies *interrupta* in the West and *summersi* in the East

——— borders of the prospecies *pallidula*

·—·—·—· borders between the Western and Eastern branches of prospecies *pallidula*

at least as **prospecies** (according to SCHILDER, 1966a, p. 184), *viz.* the western *interrupta,* the central *pallidula,* and the south-eastern *summersi.* While the western and the south-eastern prospecies living on the verge of the whole area of distribution of the species are confined to relatively small areas, the central *pallidula* occupies a large area, so that it has branched into three **subspecies:** the northern *luchuana,* the central *pallidula* and the eastern and southern *rhinoceros.* The two last named subspecies may be divided each into two taxa of lower though still subspecific rank according to the International Rules of Zoological Nomenclature, called **infraspecies** (by SCHILDER, 1966a, p. 185), *viz. pallidula* into a possibly ecological local variant *dayritiana* in the north, and the widely distributed typical *pallidula*; and *rhinoceros* into the West Australian *simulans* and the eastern *rhinoceros* almost only on zoogeographical reasons. Besides, the infraspecies *pallidula* and *rhinoceros,* and the prospecies *summersi* provisionally can be divided into several unnamed **groups** according to their habitat. The names *prestoni* and *vivia* should not be used: the former is an absolute synonym of *interrupta* established on the erroneous assumption that GRAY's name was preoccupied by a *nomen nudum,* the latter designates typical *rhinoceros* from Fiji.

It seems desirable to designate the lowermost units by the letters A to N, so that the species *interrupta* may be classified as follows (p = prospecies, s = subspecies, i = infraspecies):

A (p) *interrupta* (= *prestoni*) Ceylon to Puket Island, south coast of Sumatra and Java, Bali
(p) *pallidula*
B (s) *luchuana* Ryukyu Islands (Okinawa)
(s) *pallidula*
C (i) *dayritiana* Coron Bay (Philippines); Okinawa?
(i) *pallidula*
D *ex* Philippines North Borneo to Palau Islands and Menado
E *ex* Indonesia Singapore and South Java to Western New Guinea
(s) *rhinoceros*
F (i) *simulans* North West Australia to Sharks Bay
(i) *rhinoceros*
G *ex* Bismarck Archipelago (not yet known from Eastern New Guinea)
H *ex* Solomon Islands (not yet known from the New Hebrides)
J *ex* New Caledonia and Loyalty Islands
K *ex* Queensland to Capricorn Islands; Lord Howe Island
L *ex* Fiji (= *vivia*) to Wallis Island, Samoa, and rarely Tonga
(p) *summersi*
M *ex* Fiji (and Samoa?)
N *ex* Tonga

CHARACTERS OF THE SHELLS

The seven named taxa can be distinguished generally according to the following key:

1 Teeth very fine and numerous, short; dorsum with three broad zones the central of which may be slit ..... (p) *interrupta*
– Teeth coarser and less numerous, more produced; dorsum with four narrow distant zones which often become indistinct 2
2 Teeth less distant; shell mostly rather broad: ..... (p) *pallidula* 3

– Teeth very distant; shell slender, especially in front ..... (p) *summersi*
3 Spire blotch mostly distinct, blackish; fossula flattened ..... (s) *luchuana*
– Spire blotch absent (protoconch only blackish); fossula concave 4
4 Anterior extremity constricted; margins unspotted ..... (s) *pallidula* 5
– Anterior extremity broad, dorsally callous; margins often finely spotted (s) *rhinoceros* 6
5 Shell very broad, callous; columellar teeth produced almost to the outer margin .... (i) *dayritiana*
– Shell rather slender; columellar teeth less produced, attaining about the center of the lip ..... (i) *pallidula*
6 Generally larger and more slender; from West Australia ..... (i) *simulans*
– Generally smaller and broader, callous; from the Pacific ..... (i) *rhinoceros*

However, the exact determination of many shells from unknown habitat is often impossible, though extremes always are well recognizable: for the indicated characters are rather variable.

The quantitative, *i. e.* the measurable characters have been tabulated in Table 1: the columns indicate n = the number of examined shells, L = the length (in mm), BL = the relative breadth (in % of the length), LT and CT = the relative closeness of labial teeth and of columellar teeth respectively (both expressed by letters according to the tables published in SCHILDER, 1958); in each column, the two marginal figures express the limits of the "usual variation," *i. e.* the limits of two thirds of specimens most approaching the median (see SCHILDER & SCHILDER, 1966c, p. 209), the central figure (in parentheses) indicates the median itself which approaches the mean between the lower and upper limits of the usual variation.

In diagram Figure 1 the length has been plotted against the relative breadth; the letters A - N indicate the mean between the limits of usual variation (not the median of all specimens); the circles around the centers A, B (cross-hatched), C, M+N, and X (*i. e.* the sum of D to

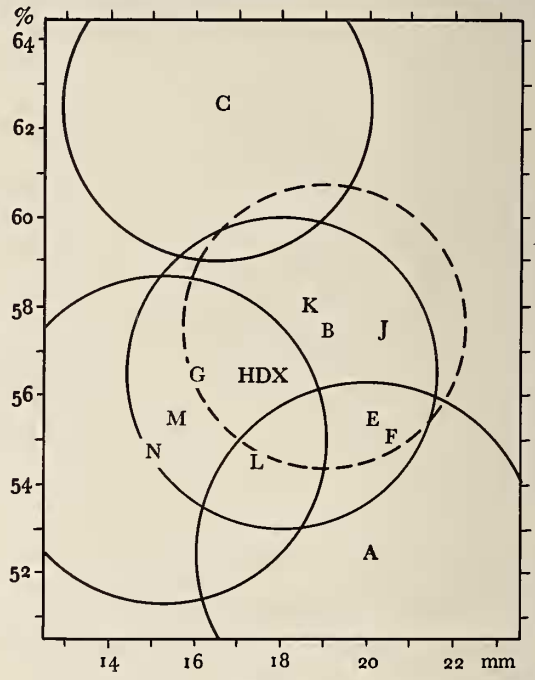


Figure 1

Table 1

		n	L	BL	LT	CT
Blasicrura						
interrupta	A	409	17(20)23	51(52)54	s(u)w	s(u)w
luchuana	B	37	17(19)21	56(57)59	o(p)q	o(p)r
dayritiana	C	19	15(16)18	60(63)65	m(m)n	l(n)p
pallidula	D	21	15(17)20	55(56)58	p(q)s	n(p)r
pallidula	E	24	17(20)23	54(55)57	o(q)r	m(o)q
simulans	F	12	17(20)24	54(55)56	q(r)t	n(p)r
rhinoceros	G	580	14(16)18	55(57)58	q(r)t	p(r)s
rhinoceros	H	33	15(17)19	55(56)58	q(r)s	o(q)s
rhinoceros	J	44	18(21)23	56(57)59	q(r)s	o(p)r
rhinoceros	K	68	16(18)21	56(57)60	p(r)s	n(p)r
rhinoceros	L	22	15(18)20	52(55)57	r(s)t	o(q)r
summersi	M	142	14(15)17	53(55)58	o(p)q	i(k)m
summersi	N	27	13(15)17	52(54)57	o(o)p	i(i)i
Mean of 13 areas	A - N		16(18)20	55(56)58	p(q)s	n(p)q

L) comprise two thirds of specimens most closely approaching these centers, as they pass through the crossing points of the limits of usual variation in each direction (see SCHILDER, 1966e). One will observe that three taxa indicate the corners of a triangle: the prospecies *interrupta* (A) is large and narrow, *summersi* (M+N) is small and rather narrow, and *dayritiana* (C) is extremely broad; the other taxa are rather crowded in the central area, but there are some evident peculiarities: the western E and F tend to the still more western A, and the eastern populations of *rhinoceros* (L) tend to *summersi* (M+N) inhabiting the same area; among the remaining taxa those inhabiting the peripheral areas (B, J, K) are larger than their equatorial allies (D, G, H), as it is in other cowries too (see SCHILDER, 1961).

In diagram Figure 2 the closeness of labial teeth has been plotted against the columellar teeth in the same manner. There is a similar triangular arrangement of extremes concerning the same taxa A, M+N, and C, though they are placed in a different way: *interrupta* (A) has very numerous teeth on both lips, and *summersi* (M+N) has very few, so that the circles indicating the limits of usual variation hardly cross the central circle containing all remaining taxa which are still more crowded (their common center coincides with J); the third corner (C) is less striking and refers mostly to columellar teeth.

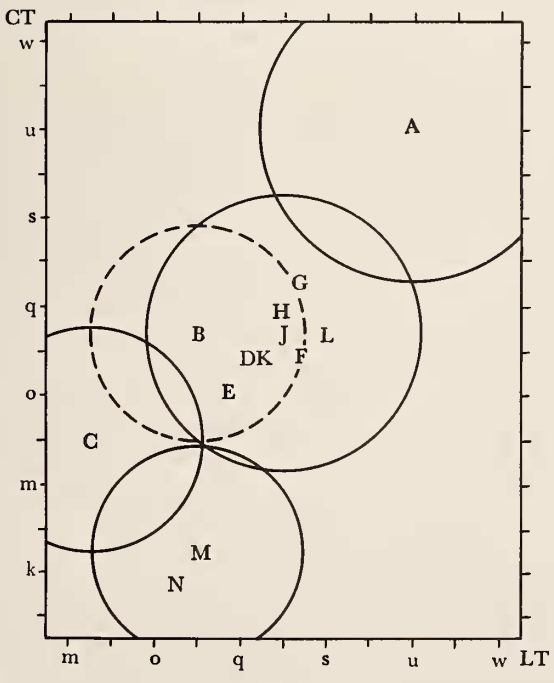


Figure 2

The main qualitative, *i. e.* not measurable characters distinguishing intraspecific taxa of the species *interrupta* are explained below; the figures 1 to 3 indicate different degrees in development of the character concerned:

AE = anterior extremity: 1 = rather constricted, mostly white, to 3 = broadly rounded with a distinct nose-like callosity which is mostly grey.

CT = columellar teeth: 1 = short, not attaining the center of the lip; 2 = more produced so that they cross the center; 3 = crossing the lip almost to the outer margin.

Fo = fossula: 1 = narrow, shallow to 3 = rather broad, concave.

Zo = two central zones: 1 = absent to obsolete, distant; 2 = distinct, distant, narrow, continuous to hardly interrupted; 3 = broad, approaching each to the other, connected by a less darkly colored area or even quite confluent so that there is one central zone only which mostly becomes dissolved into rather longitudinal spots as are the terminal zones also.

Sp = spire blotch: 1 = always absent; 2 = rarely indistinctly indicated; 3 = well developed in about two thirds of specimens. The black spire blotch is situated on the right side of the spire, and it must not be confused with the blackish protoconch, visible in many shells of all intraspecific taxa of *interrupta*.

LS = lateral spots: 1 = always absent; 2 = mostly present though scarce and small; 3 = numerous, well visible.

The prevalent formation of these six qualitative characters of structure and color has been indicated in Table 2.

Table 2

		AE	CT	Fo	Zo	Sp	LS
Blasicrura							
interrupta	A	3	1	2	3	1	1
luchuana	B	1–2	2	1–2	1	3	1
dayritiana	C	1	3	2	1	2	1
pallidula	D	2	2	2	2	1	1
pallidula	E	2	2	2	2	1	1
simulans	F	2–3	2	3	2	1	2
rhinoceros	G	3	2	3	2	1	2
rhinoceros	H	3	2	3	2	1	2
rhinoceros	J	3	2	3	2	1	3
rhinoceros	K	3	2	3	2	1	2
rhinoceros	L	3	2	3	2	1	2
summersi	M	1	3	1	1–2	1	1
summersi	N	1	3	1	1–2	1	1–2

Other qualitative characters seem to be less important, *e. g.* the closeness of the dorsal specks, the presence of a pale dorsal line, the degree and the direction of the interruptions of the dorsal zones (which often look more interrupted in worn shells than in fresh specimens), the development of the grey spot above the anterior extremity (which becomes well marked in races with callous extremity and is dark brown in worn shells), the dull base (said to be a character of *dayritiana*); the existence of small terminal spots chiefly on the right margin of the anterior extremity seems to be peculiar to *summersi* (it has been interpreted as beginning of the typical spots of *Blasicrura quadrimaculata*).

The only shell said to come from Lord Howe Islands (see above) is large (23 mm), broad (64 %), with rather distant teeth (class n:n); it is callous with attenuated extremities, the columellar teeth cross only half the lip, the much worn dorsum exhibits two distant central zones, each dissolved into three small square spots; it possibly may be intermediate between *Blasicrura rhinoceros* and *B. summersi,* but as its formula does not fit to the diagrams 1 and 2, it possibly constitutes a new southernmost local race.

CHARACTERS OF THE ANIMALS

The animal's color has been said to be different in *rhinoceros* and *summersi* (Cernohorsky, 1966, pp. 196, 197) as well as Mrs. H. Minzak (*in litt.*) discovered differences between the true *luchuana* (animal black) and specimens from Okinawa without the spire blotch (animal grey with white spots). These indications, however, seem to be very questionable, as my own examination of specimens (preserved in alcohol) showed great variation within the races and no consistent differences between the races nor the sexes: in 6 *Blasicrura luchuana* from Okinawa (with or without spire blotch), 2 *B. rhinoceros* from Queensland and 2 *B. summersi* from Fiji the mantle varies from grey to black with or without pale appendices, and the sides of the foot vary from pale fulvous marbled with dark specks in various degrees to entirely black; the animal of the only young specimen (*B. summersi*) was even dark carmine.

The radula, however, shows remarkable differences, so far as the ten examined radulae permit one to form an opinion. In the six *Blasicrura luchuana* from Okinawa with or without a spire blotch (5 ♀ ♀, 1 ♂) the anterior edge of the median tooth shows 3 denticles, and that of the admedian tooth shows also 3 denticles only, as it is in *B. quadrimaculata* (Gray), too. On the other hand, in the 2 *B. rhinoceros* (♀ and ♂) and in the 2 *B. summersi* (♂ and young) the median shows 5 denticles, and the admedian shows 4 denticles, as it is in *B. coxeni* (Cox). Besides, in all specimens from Okinawa the lateral teeth are rather broad and hook-like, with coarse denticles, while all specimens from Queensland and Fiji show the laterals very slender with weak denticles on the tip; these differences are comparable to those observed in the genus *Staphylaea* (see Schilder & Schilder, 1966d, where figure 1 recalls *B. luchuana* though in the latter the lateral denticles are coarser, whereas figure 2 recalls *B. rhinoceros* and *B. summersi*); but in *Staphylaea* this dimorphism is rather sexual, while the differences in *Blasicrura interrupta* could be racial. It is to be regretted that the radula of the western *B. interrupta,* the Malayan *B. pallidula* and the typical Melanesian *B. rhinoceros* is still unknown.

EVOLUTION

According to the characters discussed above, the probable intraspecific evolution of *Blasicrura interrupta* could be outlined as follows (see Figure 3):

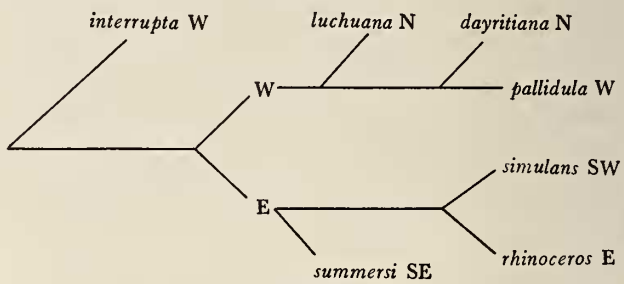


Figure 3

1. The common ancestor is believed to recall the present Malayan *Blasicrura pallidula* which is intermediate morphologically and central geographically.

2. First of all, *B. interrupta* separated on the western border of the inhabited area, by the teeth becoming finer and the dorsal zones approaching each other; these characters became stabilized genetically so that this representative of the Indian province may be regarded almost of specific rank as it overlaps, in southern Java, the area of *B. pallidula* mostly living in the Pacific province.

3. Within the latter branch, the separation of a western group (*B. pallidula*) and an eastern group (*B. rhinoceros*) evidently dates from less old times, though the morphological differences in the radula and lateral spots seem to be rather constant.

4. In the eastern group, *B. summersi* separated in early times on its south-eastern border; though its characters (distant teeth, shallow fossula) are far less striking, *B. summersi* must have been stabilized genetically so that a few true *B. rhinoceros* now can intrude into its area without causing evident hybrids.

5. The separation of *B. luchuana,* however, on the northern border of *B. pallidula* must be far younger, as its chief character (the black spire blotch) is developed in only two thirds of specimens in the restricted area of the Ryukyu Islands; one third is hardly distinguishable from the Malayan *B. pallidula.*

However, if one restricts *luchuana* to such specimens coming from Okinawa which exhibit the spire blotch, then *luchuana* should be regarded as a prospecies contemporary with *summersi,* as it becomes overlapped by the Malayan *pallidula*; the medians of the measurable characters (Table 1) of the restricted *luchuana* do not become altered.

6. The status of the recently discovered *B. dayritiana* is still uncertain: it may be an ecological variety only of *B. pallidula,* as similar shells seem to occur also in Okinawa, or a recent local mutant just beginning to spread in the north of the area inhabited by *B. pallidula* and *B. luchuana.*

7. The establishing of *B. simulans* can hardly be justified by morphological reasons; but as it is probable that, like in other cowries, the isolated West Australian populations became genetically different from the eastern *B. rhinoceros, B. simulans* may be regarded as the youngest separable unit on zoogeographical grounds.

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